Süleyman Demirel Üniversitesi Orman Fakültesi Dergisi
Seri: A, Sayı: 1, Yıl: 2008, ISSN: 1302-7085, Sayfa: 61-71

ADAPTATION OF SOME POPLAR CLONES TO THE LAKE DISTRICT IN TURKEY

Korhan TUNÇTANER* Halil Barış ÖZEL

University of Zonguldak Karaelmas, Faculty of Forestry, 74100 BARTIN
* tunctaner@yahoo.com

ABSTRACT

In this study, growth performances of poplar clones at the trial site at Isparta province were investigated. Experiment located at ORMA (Wood Products Integrated Industry and Trade Inc.) were established with *14 P.x euramericana* and 10 *P.deltoides* clones using two replicated randomised block design in 6 x 6 meter spacing. Evaluations on heigt, diameter, survival, index value and volume production of the clones were made at the end of 8 year rotation period. Some of the clones showed better growth performances and survival rates than control clone I-214. Stem analysis was made to find the stem volumes of the top 9 poplar clones determined from the assesment of index values, and then calculate volume productions and mean volume increments of the clones per hectare. *P.x euramericana* "39/61" had the maximum mean annual increment (18.9 m^3 /ha/year) and it was followed by "I-214"(17.4 m^3 /ha/year). Factor analysis made for 9 clones concerning their growth values, survival and some characteristics of the trial site has showed that mean annual volume increment (MAI) was the most important variable among the variables in Component 1. Three groups of the clones were seperated by discriminant analysis. It is concluded that The *P.x euramericana* clones in the first group and *P.deltoides* clones in the second group showed considerably good adaptation capacities to the Lake District in Turkey.

Keywords : Poplar, Clone, Adaptation, Factor and Discriminant Analysis

BAZI KAVAK KLONLARININ TÜRKİYE'DE GÖLLER YÖRESİNE ADAPTASYONU

ÖZET

Bu çalışmada, Göller Bölgesi'ni temsilen Isparta'da tesis edilmiş olan deneme alanında, bazı kavak klonlarının adaptasyon yetenekleri araştırılmıştır. Deneme alanı, ORMA (Orman Mahsulleri İntegre Sanayi ve Ticaret A.Ş) kavak plantasyon alanında 14 adet *Populus x euramericana* ve 10 adet *Populus deltoides* klonu ile rastlantı blokları deneme desenine gore 6 x 6 m dikim aralığı ile tesis edilmiştir. 8 yıllık rotasyon dönemi sonucunda klonların boy, çap, yaşama yüzdesi, indeks değerleri ve hacim üretimleri değerlendirilmiştir. En yüksek indeks değerlere sahip ilk 9 klonun, hacimleri gövde analizleri yardımıyla bulunmuş ve klonların hektardaki ortalama hacim üretimleri ve artımları hesaplanmıştır. En yüksek ortalama hacim artımını *Populus x euramericana* "39/61" klonu göstermiş (18,9 m^3/ha/yıl) ve bu klonu 17,4 m^3/ha/yıl ile *Populus x euramericana* "I-214" klonu takip etmiştir. Bu 9 klon için büyüme değerleri, yaşama yüzdesi ve deneme alanına ait bazı yetişme ortamı özellikleri esas alınmak suretiyle uygulanan faktör analizi sonucunda, 1. faktör içindeki ortalama yıllık hacim artımı (MAI) en önemli değişken olarak saptanmıştır. Diskriminant analizine göre klonlar 3 gruba ayrılmışlar ve ilk grup içinde yer alan "39/61" ve "I-214" nolu euramerican klonları Göller Bölgesi'ne uyum sağlayan klonlar olarak belirtilebilir.

Anahtar Kelimeler: Kavak, Klon, Adaptasyon, Faktör ve Diskriminant Analizi.

1. INTRODUCTION

Various *Populus x euramericana* (*P. deltoides x P. nigra)* and *P. deltoides* clones have been widely used at plantations in temperate regions of Turkey and their annual volume increment have varied between 15-36 m^3/ha in 10-13 year rotation period (Birler et al., 1978; Tunçtaner, 1991; Tunçtaner et al., 1998; 2004). Poplar wood production has reached to nearly 4 million m^3 and harvested wood is used for rural and industrial needs.

Modern poplar cultivation techniques have been practised in most of the sites where *P. x euramericana* or *P. deltoides* clones are cultivated. But in some parts of the central, eastern and southeastern regions of Turkey, black poplar cultivars are cultivated with traditional methods. Riverside or streamside, field and roadsides plantings have been established in rows for centuries by farmers in Anatolia (Anon., 1994; Tunçtaner, 1998; Işık and Toplu, 2004). In some regions of Anatolia where cultivated land is limited for agriculture, wood demand is very high. Therefore, road plantings are optimal solutions for an ideal land-use system in these regions. They protect arable land and provide wood for rural needs. Internationally registered black poplar clones *P. nigra* "Gazi" and *P. nigra* "Anadolu" have been cultivated in Central Anatolia, East Anatolia and Southeast Anatolia. According to the latest inventory data, approximately 150.000 ha of poplar plantations have been established, of which 80.000 and 70.000 ha are hybrid poplars (*P. x euramericana* and *P. deltoides*) and black poplars (*P. nigra*) respectively. Almost 40% of black poplars are not in the form of block plantations but of road plantings along water canals, stream banks and around irrigated fields (Anonymous, 1999).

Industries consuming poplar wood have developed very fast in recent years. These industries (furniture, packing, particleboard, plywood, matches, paper, etc.) mostly use the wood of *P.x euramericana* and *P. deltoides* clones. Nearly all wood production from hybrid poplars (2.100.000 m^3) is consumed by industries mentioned above. More than %80 of black poplar wood (1.700.000 m^3) is utilized as round wood for rural construction purposes and for daily needs of rural people.

Research studies on selection of the most suitable hybrid poplar (*P. x euramericana*) and eastern cottonwood (*P. deltoides*) clones have been carried out in Turkey for many years (Semizoğlu, 1967; Tunçtaner, 1991; Tunçtaner et al., 1994; Tunçtaner, 2002; 2003). The results showed that hybrid poplars, particularly the clone *P. x euramericana* "I-214" had a great adaptation capacity to the site conditions up to 1000 m altitudes in continental regions. In accordance with this result, the clone "I-214" has been started to grow in Central Anatolia Region. In Lake District, at the vicinity of Isparta province, 450 ha poplar plantations has been established with the clone "I-214" by ORMA (Wood Products Integrated Industry and Trade Inc.). ORMA recycles forest waste for chipboard production and has developed a plantation project to grow selected poplar clones and some other tree species for industrial use. Accordingly, an experiment was established in this plantation site at Isparta to compare the growth performances of 24 poplar clones and select some of them as alternatives to "I-214".

2. MATERIAL AND METHODS

Site conditions of the trial site and the clones used in experiment were given in Table 1 and Table 2. *P. x euramericana* "I-214" was also included in trial site as a control clone. 16 saplings from each clone were planted with 6 x 6 m spacing in randomized block design in with two replications.

Height (H) and diameter (D) measurements of the trees were taken at the end of 8 year rotation period. Survival rates of the clones were calculated as the number of living trees (N) in a plot over the initial number of planted saplings Arc.Sin transformed values were used in the analysis. The evaluations based on height, diameter and survival percentages of the clones were made by using analysis of variance (ANOVA). Furthermore, index values (IV) of the clones were calculated by the following equation;

Table 1. Site conditions of the trial site

Site		Climate		Soil	
Location	Isparta	Mean annual rainfall	613.6 mm	Texture	Sandyloam
Latitude	37º 45ˡ N	Mean annual temperature	12.1 ºC	Soil dept	> 120 cm
Longitude	30º 33ˡ E	Maximum temperature	37.5 ºC	Salinity (ms/cm)	1.4
Altitude	1043 m	Minimum temperature	-17.8 ºC	Reaction (pH)	7.6
		Mean relative humidity	62 %	Organic matter (%)	1.4
				$CaCO_3$	4.7

Table 2. The poplar clones in the trial site

Clones	Species	Origin
Samsun	*P. deltoides*	Turkey
709	*P. deltoides*	Italy
6261	*P. deltoides*	Netherland
PE.3-71	*P. deltoides*	Italy
S.307-26	*P. deltoides*	Belgium
PE.4-71	*P. deltoides*	Italy
PE.19-66	*P. deltoides*	Italy
R.87	*P. deltoides*	Italy
LUX (69/55)	*P. deltoides*	Italy
6340	*P. deltoides*	Netherland
45/51	*P. deltoides*	Italy
L.Avanzo	*P. x euramericana*	Italy
Guardi	*P. x euramericana*	Italy
39/61	*P. x euramericana*	Italy
Longhi	*P. x euramericana*	Italy
CB.7	*P. x euramericana*	Italy
Branegesi	*P. x euramericana*	Italy
10/62	*P. x euramericana*	Italy
Gattoni	*P. x euramericana*	Italy
565/240	*P. x euramericana*	Hungary
I-214	*P. x euramericana*	Italy
Bellini	*P. x euramericana*	Italy
Carpaccio	*P. x euramericana*	Italy
Ostia	*P. x euramericana*	Yugoslavia

$$IV = (D/2)^2 \times H \times 3.1416 \times N \qquad (1)$$

A preliminary selection of the clones was made according to the results of mean index values of the clones and 9 clones were selected to determine stem volume productions. For this purpose, the method of stem analysis was used (Birler et al, 1978; Tunçtaner, 1990; Tunçtaner et al., 1994). ANOVA was also used for comparisons of mean stem volumes of the clones. Volume productions of the clones (m^3/ha) were calculated using the data of tree volumes obtained from stem analysis of sample trees for each clone and number of the trees per hectare. Duncan's Multiple Range Test was used for the grouping of the clones incase significant differences appeared between the volumes of the clones. The effective variables concerning site conditions of the trial site (Table 1) were also considered to determine the adaptation capacity of selected 9 clones to Isparta province.

In explaining the genetic variance to determine the most effective components on wood productions of the clones and to create groups of the clones on the basis of these components, factor analysis and discriminant analysis as multi-dimension statistical techniques were applied. To achieve this, Version 9.0 of Statistical Package for Social Science (SPSS) was used. Names, units and labels of the variables are given in Table 3.

Table 3. Names, units and labels of the variables.

Variables	Units	Labels
Altitude	m	AL
Mean annual rainfall	mm	MAR
Mean annual temperature	ºC	MAT
Maximum temperature	ºC	MAXT
Minimum temperature	ºC	MINT
Mean relative humidity	%	MRH
Soil dept	cm	SD
Salinity	ms/cm	S
Reaction	-	PH
Organic matter	%	OM
$CaCO_3$	%	CC
Diameter	cm	D
Height	m	H
Survival rate	%	SR
Stem volume	m^3	SV
Index value	Dm^3	IV
Volume/Hectare	m^3/ha	VPH
Annual increment per hectare	m^3/ha	MAI

3. RESULTS AND DISCUSSION

The results of ANOVA for diameter and survival values of the clones showed significant differences at 0.01 confidence level (F = 3.31**, F = 3.96**). Diameter growth varied between 31.2 cm (clone 39/61) and 23.1 cm (clone Gattoni). *P.x*

euramerican clones "39/61" and "Ostia" had better diameter growth than control clone "I-214". Survival percentages of the clones varied between 96 % and 33 %. The best clone is *P.deltoides* "709" and most of the clones had better survival percentages than control clone *P.x euramericana* "I-214" (Table 4). A similar result was obtained from another trial site located in central Anatolia, Kırşehir-Kocabey ; At the end of 11 year rotation period, *P.x euramerican* clone "Ostia" showed better diameter growth than control clone "I-214" with 24.5 cm and 22.2 cm respectively (Tunçtaner et al., 1998).

In some trial sites (Izmit, Bursa and Meriç) located at low altitudes in Marmara region, 16 *P.x euramerican* and 11 *P.deltoides* clones showed different variations regarding their growth performances and survival in 12 year period. The clone "39/61" ranked in different order at the trial sites on the basis of diameter growth; with 31.2 cm in 13th order at Izmit, with 37.5 cm in third order at Bursa and with 29.5 cm in second order at Meriç. The clone "Ostia" generally showed better growth performances and survival percentages than "I-214" at the trial sites (Tunçtaner et al., 1998; 2004).

Table 4. Results of the ANOVA, mean values and rank orders of the clones

Diameter (cm) F = 3.31**		Height (m) F = 1.52 NS		Survival (Arc.Sin.) F = 3.96**		Index Values F = 1.96 NS	
39/61	31.2	PE.19-66	21.2	709	79.4	PE.19-66	17100.4
Ostia	29.8	Guardi	20.3	S.307-26	79.4	R.87	15956.5
I-214	29.5	709	20.1	R.87	79.4	45/51	15185.7
Guardi	29.2	Lux	20.1	Branegesi	74.6	S.307-26	14848.0
PE.4-71	28.9	Samsun	19.9	45/51	68.8	I-214	14688.2
CB.7	27.8	R.87	19.8	PE.19-66	67.3	10/62	14363.5
PE.19-66	27.7	Carpaccio	19.8	6340	67.3	709	14207.6
PE.3-71	27.6	CB.7	19.7	Ostia	67.3	39/61	13904.1
L.Avanzo	27.4	39/61	19.7	Gattoni	66.5	Samsun	13808.5
10/62	27.2	L.Avanzo	19.5	Samsun	64.4	6261	13196.3
45/51	27.1	I-214	19.5	10/62	64.4	CB.7	12752.0
Carpaccio	26.4	565/240	19.3	6261	61.1	Branegesi	12681.5
S.307-26	26.3	PE.4-71	19.3	Longhi	58.0	PE.3-71	12485.6
Samsun	26.1	Ostia	19.2	PE.3-71	56.3	L.Avanzo	12166.2
R.87	26.1	6261	19.1	I-214	56.0	Carpaccio	11445.8
6261	26.0	10/62	19.1	Carpaccio	54.5	Ostia	10780.4
565/240	25.4	PE.3-71	19.1	CB.7	54.2	Gattoni	10562.2
Bellini	25.1	Bellini	18.9	L.Avanzo	53.7	6340	10345.4
Lux	25.0	45/51	18.7	565/240	53.7	565/240	10289.3
709	24.5	Branegesi	18.4	Lux	50.2	PE.4-71	9421.3
Branegesi	24.1	S.307-26	18.0	Bellini	48.4	Lux	9404.8
Longhi	24.0	Gattoni	18.0	39/61	48.2	Longhi	9280.6
6340	23.5	Longhi	17.9	PE.4-71	42.9	Bellini	8410.2
Gattoni	23.1	6340	17.7	Guardi	35.0	Guardi	7738.2

Differences between the clones regarding their height growth and index values were not significant (Table 4). Considering the index values, the best 9 clones were selected and stem volumes of the clones were calculated by stem analysis. Growth values of these clones were given in Table 5.

The results of the ANOVA applied for stem volumes of the clones showed significant differences at 0.01 confidence level (F= 6.22**). According to Duncan test at 0.01 level, *P.x euramerican* clones "39/61" and "I-214" were in the first group and had better stem volumes than *P.deltoides* clones and the other hybrid clones (Table 6). Accordingly, these 2 clones ranked in first and second order concerning their volume productions and annual volume increments per hectare (Table 5).

The comparison between the mean values of *P.xeuramericana* and *P.deltoides* clones regarding their volume productions (Table 5, 6) indicated that in continental regions at high altitudes *P.x euramericana* clones generally have better growth performance than *P. deltoides* clones. By contrast, at low altitudes in temperate regions, *P.deltoides* clones show better growth performances than *P.x euramericana* clones. In Black Sea Region, at the end of 13 year rotation period, *P.deltoides* clones "Samsun" and "S.177-3" had 260.4 m^3 and 201.1 m^3 volume productions per hectare, while *P. x euramericana* "I-214" had 122.3 m^3 /ha (Tunçtaner et al., 1994).

Table 5. Growth values of the clones obtained from stem analysis.

Clones	Spacing (m)	Mean Diameter (cm)	Mean Height (m)	Mean Stem Volume (m^3)	Volume per Hectare (m^3/ha)	Volume Increment (m^3/ha/yıl)
39/61	6 x 6	29.7	20.0	0.545	151.4	18.9
I-214	6 x 6	28.8	19.5	0.501	139.2	17.4
PE.19-66	6 x 6	26.8	20.2	0.469	130.3	16.3
Samsun	6 x 6	25.1	20.8	0.432	120.0	15.0
R.87	6 x 6	25.4	20.2	0.410	113.9	14.2
10/62	6 x 6	26.4	18.8	0.401	111.4	13.9
S.307-26	6 x 6	24.7	18.8	0.370	102.8	12.8
45/51	6 x 6	24.9	18.7	0.358	99.5	12.4
709	6 x 6	23.2	20.3	0.350	97.2	12.1

Table 6. Comparison of volume productions of the clones.

Clones		Mean Volume (m^3)	
39/61	*(P. x euramericana)*	0.545	
I-214	*(P. x euramericana)*	0.501	
PE.19-66	*(P. deltoides)*	0.469	
Samsun	*(P. deltoides)*	0.432	p = 0.01
R.87	*(P. deltoides)*	0.410	
10/62	*(P. x euramericana)*	0.401	
S.307-26	*(P. deltoides)*	0.370	
45/51	*(P. x euramericana)*	0.358	
709	*(P. deltoides)*	0.350	

In Marmara region , mean volume productions of *P.deltoides* "S.307-26", "Samsun" and "Lena" clones per hectare in 12 years, were calculated as 287.7 m^3, 261.9 m^3 and 242.8 m^3 respectively, while this was calculated as 203.8 m^3 for *P. x euramericana* "I-214" (Tunçtaner et al., 2004). Therefore, research studies have been concentrated on *P.deltodes* to select the promising clones to be established at different sites for industrial wood production. Intra and interspecific crossing programs have also been in progress and some promising clones have recently been revealed (Tunçtaner, 2002). The success of breeding, micro propagation, genetic engineering and molecular biology studies on *P.deltoides* in various countries was also reported by many scientists (Gaget et al., 1984; Michel et al., 1989; Bisoffi, 1992; Mccown, 1997; Ahuja, 1997; Cervera et al., 1997). The data obtained from growth performances of 9 poplar clones and some site characteristics of the trial site were processed by factor analysis. The correlation matrices of the 18 variables given in Table 7 are the first input for factor analysis.

Table 7. Correlation coefficients of the variables

	AL	MAR	MAT	MAXT	MINT	MRH	SD	S	PH
AL	1.00	-0.191	0.577	-0.433	-0.528	-0.195	0.562	0.201	-0.465
MAR		1.00	-0.523	-0.045	0.226	0.253	-0.405	-0.535	0.277
MAT			1.00	-0.053	-0.561	-0.180	0.866**	0.021	-0.470
MAXT				1.00	0.535	-0.125	-0.433	-0.485	-0.280
MINT					1.00	0.587	-0.718*	-0.321	0.344
MRH						1.00	-0.195	-0.382	0.753*
SD							1.00	0.310	-0.378
S								1.00	-0.263
PH									1.00
OM									
CC									
D									
H									
SR									
SV									
IV									
VPH									
MAI									

	OM	CC	D	H	SR	SV	IV	VPH	MAI
AL	0.146	-0.072	-0.371	0.216	0.213	-0.295	-0.186	-0.296	-0.292
MAR	0.216	-0.275	-0.046	0.235	0.100	-0.034	0.002	-0.034	-0.035
MAT	0.400	0.250	-0.461	0.487	0.259	-0.220	-0.244	-0.221	-0.219
MAXT	-0.396	-0.287	0.487	0.322	-0.372	0.562	-0.084	0.562	0.557
MINT	-0.542	-0.342	0.654	-0.092	-0.299	0.585	0.173	0.586	0.582
MRH	-0.177	-0.180	0.086	-0.117	0.156	0.069	-0.104	0.069	0.067
SD	0.693*	0.433	-0.504	0.433	0.272	-0.274	-0.029	-0.275	-0.270
S	0.138	0.400	-0.026	-0.369	0.025	-0.115	0.583	-0.114	-0.109
PH	-0.263	-0.168	-0.003	-0.508	0.162	-0.165	-0.158	-0.165	-0.168
OM	1.00	0.590	-0.471	0.508	0.257	-0.246	0.185	-0.246	-0.241
CC		1.00	-0.209	-0.145	-0.039	-0.183	0.038	-0.183	-0.180
D			1.00	-0.009	-0.886**	0.936**	-0.039	0.937**	0.936**
H				1.00	-0.046	0.326	0.000	0.326	0.327
SR					1.00	-0.847**	0.327	-0.847**	-0.847**
SV						1.00	-0.024	1.000**	1.000**
IV							1.00	-0.024	-0.021
VPH								1.00	1.000**
MAI									1.00

* Correlation is significant at the 0.05 level

** Correlation is significant at the 0.01 level

In factor analysis, total variance was explained for 18 components and first 7 components having larger proportion than 1.0 in the total variance were extracted (Kaiser Criterion). Proportion of variance of the first 7 components in the total variance is 97.83 %.

In factor analysis, in the first stage, unrotated component matrix was obtained using principle component model. Later, in order to get a more reliable matrix for scientific explanation, the matrix rotated by Varimax Rotation Method was produced (Table 9).

Table 8. Total variance explained for the components

Components	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.513	36.182	36.182	6.513	36.182	36.182
2	3.653	20.292	56.474	3.653	20.292	56.474
3	2.246	12.480	68.954	2.246	12.480	68.954
4	1.630	9.054	78.008	1.630	9.054	78.008
5	1.426	7.920	85.928	1.426	7.920	85.928
6	1.135	6.306	92.234	1.135	6.306	92.234
7	1.008	5.601	97.835	1.008	5.601	97.835
8	0.390	2.165	100.000			
9	1.455E-15	8.083E-15	100.000			
10	5.074E-16	2.819E-15	100.000			
11	3.613E-16	2.007E-15	100.000			
12	1.027E-16	5.703E-16	100.000			
13	7.495E-17	4.164E-16	100.000			
14	-2.507E-17	-1.393E-16	100.000			
15	-1.578E-16	-8.766E-16	100.000			
16	-3.321E-16	-1.845E-15	100.000			
17	-3.461E-16	-1.923E-15	100.000			
18	-5.273E-16	-2.929E-15	100.000			

Table 9. Rotated component matrix[a]

	Component						
	1	2	3	4	5	6	7
MAI	0.978						
VPH	0.977						
SV	0.977						
D	0.948						
SR	-0.912						
H		0.902					
MAT		0.762				-0.513	
SD		0.704					
MRH			0.978				
PH			0.798				
MINT	0.502		0.507				
MAXT				0.828			
AL				-0.679			
CC					0.914		
OM		0.571			0.678		
MAR						0.975	
IV							0.994
S							0.609

Extraction Method: Principal Component Analysis, Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 20 iterations.

In the first component, the first 5 variables (MAI, VPH, SV, D, SR) showing high correlations were grouped. These variables have close relations with the growth of the clones. Therefore, the Component 1 was named as "Growth" component and it was represented with the variable "MAI" which had shown the maximum correlation (0.978). Using the same method, the Component 2 was named as "Site" and represented by "H", the Component 3 was named as "Climate" and represented by "MRH", the Component 4 was named as "Altitude" and represented by "AL", the Component 5 was named as "Soil" and represented by "CC", the Component 6 was named as "Rainfall" and represented by "MAR", the Component 7 was named as "Index" and represented by "IV". Consequently, the 18 variables have been decreased to 7 components with the loss of 2.2 % information. According to the results of factor analysis, clones were separated into 3 groups depending on the most important variable "MAI" in the component 1 (Table 10).

Discriminant analysis was performed on the basis of 7 effective components determined by factor analysis. According to the results of discriminant analysis, 2 discriminant functions were obtained to separate the groups from each other. Statistics of these functions are given in Table 11.

The results of classification of the clones concerning the predicted groups determined by discriminant analysis are given in Table 12. It can be stated that the classification of the clones into 3 groups based on the most important variable "MAI" was correctly made on 100 % confidence.

Table 10. Groups of the clones

Groups	Mean annual increment (m^3 /ha/year)	Number of clones
Group 1	17.4 – 18.9	2
Group 2	13.9 – 16.3	4
Group 3	12.1 – 12.8	3

Table 11. Some statistical parameters of discriminant functions.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	49.582[a]	98.5	98.5	0.990
2	0.756[a]	1.5	100.0	0.656

[a] First 2 canonical discriminant functions were used in the analysis.

Table 12. The results of classification made for grouping of the clones

	Group	Predicted Group Membership			Total
		1	2	3	
Original Count	1	2	0	0	2
	2	0	4	0	4
	3	0	0	3	3
%	1	100.0	0.0	0.0	100.0
	2	0.0	100.0	0.0	100.0
	3	0.0	0.0	100.0	100.0

[a] % 100.0 of original grouped cases correctly classified.

4. CONCLUSIONS

In this study, adaptation capacities of 24 poplar clones to the Isparta province of Lake District represented by a trial site at Isparta, were investigated. Growth and survival rates and index values of the clones were compared by ANOVA. Diameter growth and survival showed significant differences at 0.01 level (Table 4). Considering the ranks of index values of the clones, 4 *P.x euramericana* (39/61, I-214, 10/62, 45/51) and 5 *P.deltoides* clones (PE.19-66, Samsun, R.87, S.307-26, 709) were selected to estimate stem volumes and volume productions per hectare. Significant differences were found between the 9 clones regarding their stem volumes (Table 6). *P.x euramericana* clones, 39/61 and I-214 showed better volume production and mean annual volume increments per hectare than other clones (Table 5). Factor analysis made for 9 clones concerning their growth values, survival and some characteristics of the trial site has also showed that mean annual volume increment (MAI) was the most important variable among the variables in Component 1 (Table 9). 3 groups of the clones were separated by discriminant analysis (Table 12).

The priority should be given to the *P.x euramericana* clones, "39/61" and "I-214" for the plantations to be established in Lake District. ORMA (Wood Products Integrated Industry and Trade Inc.) has created a self-sustaining source for raw materials by developing a tree plantation in Isparta province. A forestation Project, have grown especially the poplar clone "I-214" and other selected seedlings and trees for industrial use. *P.x euramericana* "39/61" and some *P.deltoides* clones which have showed high survival rates and reasonable volume productions should be considered as alternative clones to I-214.

LITERATURE

Anonymous 1994. Türkiye'de Kavakçılık, Kavak ve Hızlı Gelişen Orman Ağaçları Araştırma Enstitüsü, İzmit, 224 p.

Ahuja, M.R. 1997. Transgenes and genetic instability. USDA Forest Service Gen. Tech. Rep. RM-GTR-297, pp. 90-100.

Anonymous 1999. National Poplar Commission of Turkey (Period: 1996-1999). Outline for National Reports on Activities Related to Poplar and Willow Cultivation Exploitation and Utilization. Ministry of Forestry, Ankara-Turkey, 12 p.

Birler, A.S., Umaç, A., Doğru, M., Usta, H. 1978. Marmara oryantasyon populetumunda klonların büyüme yönünden karşılaştırılmaları. Kavak ve Hızlı Gelişen Tür Orman Ağaçları Araştırma Enstitüsü. Yıllık Bülten No. 13, İzmit, 117-176.

Bisoffi, S. 1992. Multiclonal poplar plantations: Mixtures vs. Mosaics. Proceedings. 19th Session of the International Poplar Commission. Volume I, Zaragoza, pp. 496-504.

Cervera, M.T., Villar, M., Faivre-Rampant, P., Goue, M.C., Van Montagu, M., Boerjan, W. 1997. Applications of molecular marker Technologies in populus breeding. USDA Forest Service Gen. Tech. Rep. RM-GTR-297, pp. 101-115.

Gaget, M., Villar, M., Dumas, C., Lemoine, M., Teissier Du Cros, E. 1984. Poplar improvement. New strategies currently in progress in France. IUFRO Proceedings of the Joint Meeting of the Working Parties S2.02.10 Poplar Provenance and S2.03.07 Breeding Poplar. Ottowa, pp. 25-30.

Işık, F. and Toplu, F. 2004. Variation in juvenile traits of natural black poplar (*Populus nigra* L.) clones in Turkey. New Forests 27. 175-187.

McCown, B.H. 1997. Poplar shoot cultures: Their generation and use in biotechnology. USDA Forest Service Gen. Tech. Rep. RM-GTR-297, pp. 5-9.

Michel, M.F., Villar, M., Pinon, J., Teissier Du Cros, E. 1989. Recent development in the INRA poplar improvement programme. Recent Developments in Poplar Selection and Propagation Techniques. Proceedings, Meeting of the IUFRO Working Party S2.02.10.Hannmünden.

Semizoğlu, M.A. 1967. Türkiye populetumları kuruluş projesi ve Eskişehir oryantasyon populetumunun ilk müşahade sonuçları. Kavakçılık Araştırma Enstitüsü, yıllık Bülten No. 2, İzmit, 23-42.

Tunçtaner, K. 1990. Çeşitli söğüt klonlarının genetik varyasyonları ve Türkiye'nin değişik yörelerine adaptasyonları üzerine araştırmalar. Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü, Teknik Bülten No. 150, İzmit, 136 s.

Tunçtaner, K. 1991. Kuzey Amerika Karakavağı (*Populus deltoides* Batr.) orijinleri ile I-214 melez kavak klonunun büyüme yönünden karşılaştırılması. Kavak ve Hızlı Gelişen Orman Ağaçları Araştırma Enstitüsü Müdürlüğü Dergisi No: 16, İzmit, 5-26.

Tunçtaner, K., Tulukçu, M., Toplu, F. 1994. Bazı kavak klonlarının büyümeleri ve teknolojik özellikleri üzerine araştırmalar. Kavak ve Hızlı Gelişen Orman Ağaçları Araştırma Enstitüsü Müdürlüğü, Teknik Bülten No: 170, İzmit, 25 s.

Tunçtaner, K. 1998b. Conservation of genetic resources of Black Poplar (*Populus nigra* L.) in Turkey. The Proceedings of International Symposium on In Situ Conservation of Plant Genetic Diversity. Edited by Zincirci, Z. Kaya, Y. Anıkster and W.T. Adams, Ankara, pp. 265-271.

Tunçtaner, K., Tulukçu, M., Toplu, F., Durcan, E. 1998. Marmara ve Ege bölgeleri oryantasyon populetumları araştırma sonuçları. Kavak ve Hızlı Gelişen Orman Ağaçları Araştırma Enstitüsü Müdürlüğü, Teknik Bülten No: 185, İzmit, 31 s.

Tunçtaner, K. 2002. Growth trends and morphogenetic characteristic of eastern cottonwood (*Populus deltoides* Batr.) crossings. Biotechnology and Biotechnological Equipment, 16/2002/1, pp. 64-71.

Tunçtaner, K. 2003. Amerikan karakavağı (*Populus deltoides* Bartr.)'nın Türkiye kavakçılığındaki yeri. Türkiye Milli Kavak Komisyonu VII. Olağan Kurulu. Kavak ve Hızlı Gelişen Orman Ağaçları Araştırma Enstitüsü, İzmit, 116-121.

Tunçtaner, K., As, N., Özden, Ö. 2004. Bazı kavak klonlarının büyüme performansları, odunlarının bazı teknolojik özellikleri ve kağıt üretimine uygunlukları üzerine araştırmalar. Kavak ve Hızlı Gelişen Orman Ağaçları Araştırma Enstitüsü Müdürlüğü, Teknik Bülten No: 196, İzmit, 91 s.